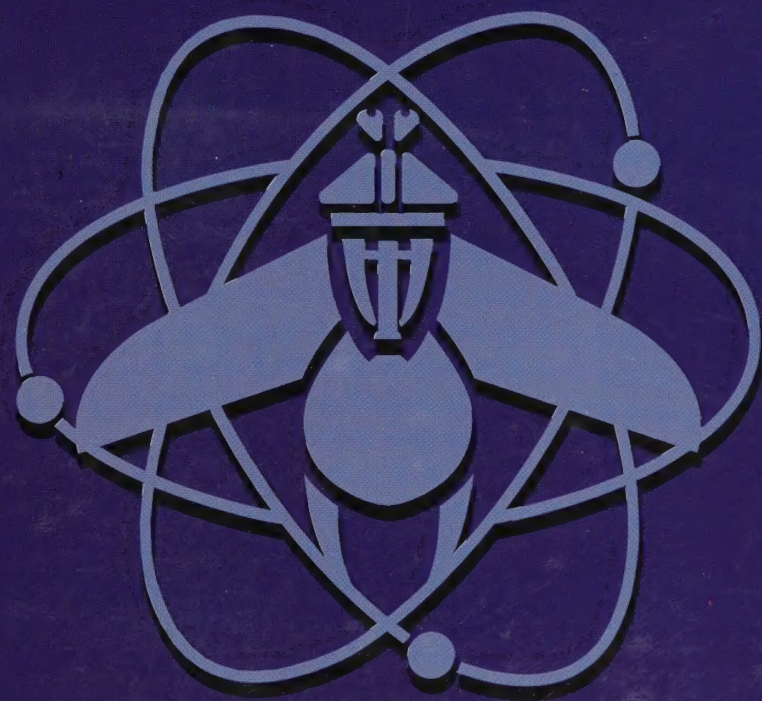
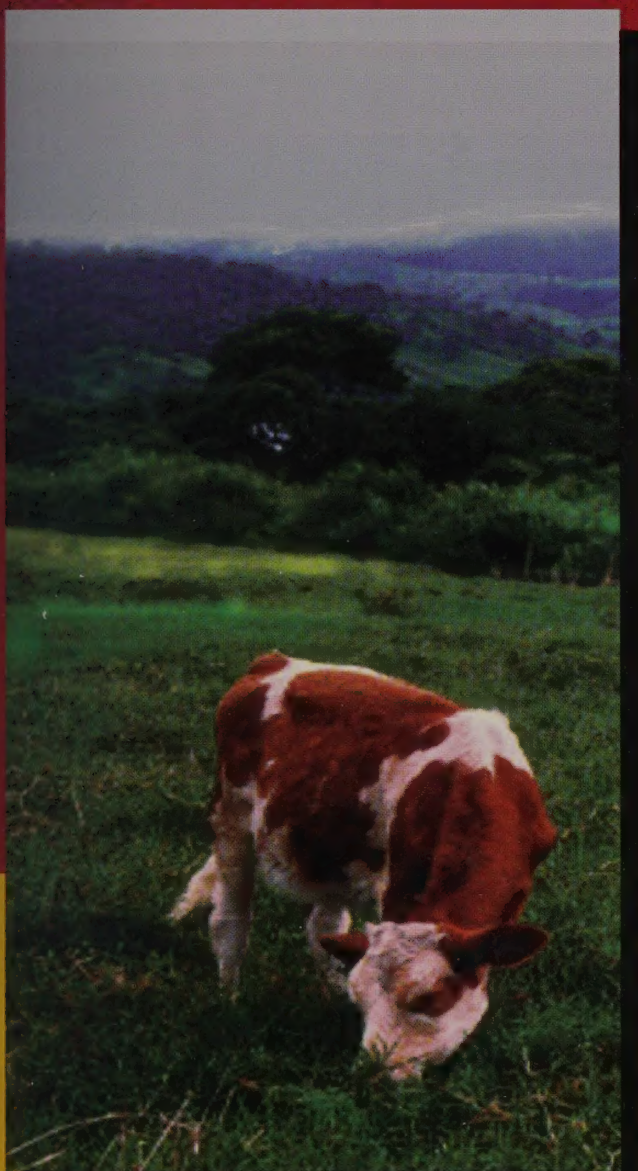




*Gusano Barrenador  
del Ganado*









# CONFERENCIA-TALLER: "USO DE SIG EN VIGILANCIA EPIDEMIOLÓGICA"

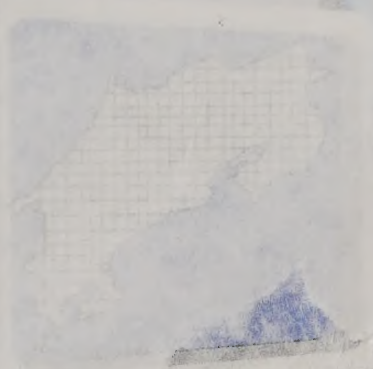
28 y 29 de abril de 1999. San José, C.R.



Programa Para La Erradicación del  
Gusano Barrenador del Ganado





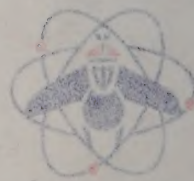


CONFERENCIA-TALLER: "USO DE SIG  
EN VIGILANCIA EPIDEMIOLÓGICA"

28 y 29 de abril de 1999. San José, C.R.



Programa Para La Erradicación del  
Gusano Barrador del Café





# PROGRAMA GUSANO BARRENADOR

República de Costa Rica-Estados Unidos de América



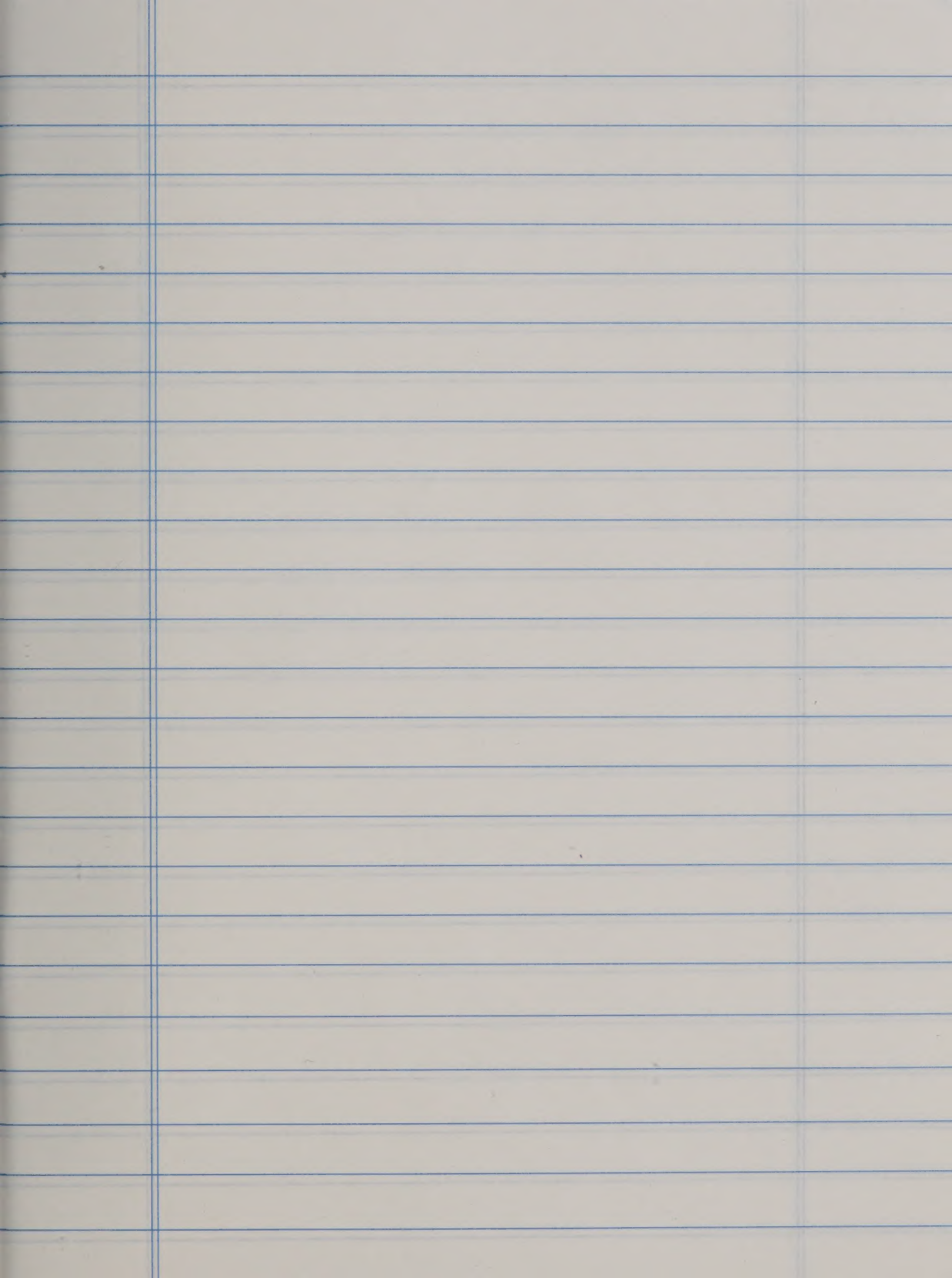
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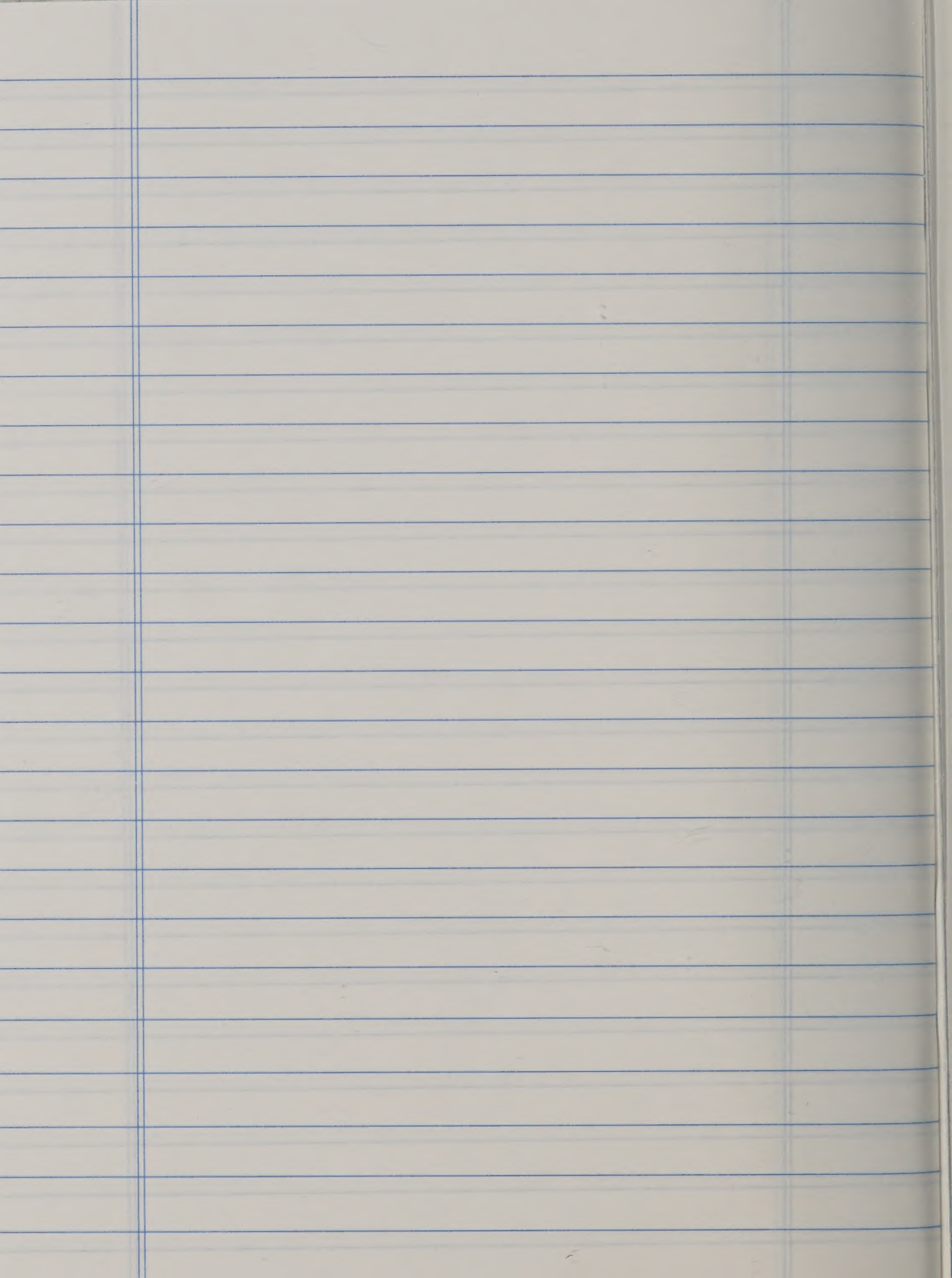


















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| COSTA RICA estará libre del<br>Gusano Barrenador... ¡Pura Vida! |               |               |

**¡Juntos podemos  
erradicar las  
Gusaneras!**



PROGRAMA GUSANO BARRENADOR  
Costa Rica  
Teléfono: 290-4114





# **Conferencia-Taller: Uso del SIG para la Vigilancia Epidemiológica**

**Abril, 1999. San José, Costa Rica**

## **Programa**

### **Martes 27 de abril**

Llegada de los participantes.

Traslado al hotel

### **Miércoles 28 de abril**

- 8:00 a.m. Bienvenida. Dr. Harold C. Hofmann y Dr. Claudio V. Carvajal O., Directores del PEGB/Costa Rica.
- 8:25 a.m. Introducción. MSc. Wilfredo Segura.
- 8:30 a.m. Exposición del Dr. Guillermo Brenes y del MSc. Rafael Arce sobre "Tecnología del SIG".
- 9:05 a.m. Sección de preguntas y respuestas.
- 9:15 a.m. Exposición del Dr. Roberto Bonilla, sobre "Vigilancia Epidemiológica".
- 9:45 a.m. Sección de preguntas y respuestas.
- 9:55 a.m. Refrigerio.
- 10:15 a.m. Exposición del Dr. Antonio Solano, sobre "Uso del SIG para el desarrollo sostenible de la actividad ganadera".
- 10:45 a.m. Sección de preguntas y respuestas.





- 10:55 a.m. Exposición de la Dra. Pamela Phillips, sobre "Uso de imágenes de satélite para identificar el hábitat de la mosca C. hominivorax".
- 11:35 a.m. Sección de preguntas y respuestas.
- 12:00 p.m. Almuerzo (libre).
- 1:00 p.m. Exposición del MSc Wilfredo Segura, sobre "Uso del SIG para la vigilancia epidemiológica".
- 2:00 p.m. Sección de preguntas y respuestas.
- 2:15 p.m. Exposición de la Dra. Giovanna Bulgarelli, sobre "Plan piloto sobre la vigilancia epidemiológica en la Región Chorotega de Costa Rica".
- 3:15 p.m. Sección de preguntas y respuestas.
- 3:30 p.m. Discusión sobre el SIG del Programa para la Erradicación del Gusano Barrenador en Costa Rica.

#### **Jueves 29 de abril**

- 8:00 a.m. Grupos de trabajo.
- 9:30 a.m. Refrigerio.
- 9:50 a.m. Grupos de trabajo.
- 12:00 p.m. Almuerzo (libre).
- 1:00 p.m. Presentación de conclusiones y recomendaciones.

#### **Viernes 30 de abril**

Excursión al Volcán Irazú – Valle de Oro y Jardines Lankaster (opcional)





# Conferencia-Taller: Uso del SIG para la Vigilancia Epidemiológica

Abril, 1999. San José, Costa Rica

## Lista de participantes

### El Salvador

Dr. Cristóbal Sepeda, OIRSA  
Dr. Ed L. Ayers, Jr. IICA

### Nicaragua

Dr. Kelly Preston, PEGB  
Dr. Eduardo Sacasa, PEGB  
Ing. Miguel A. Vega, PEGB

### Costa Rica

Sr. Charles Bertsch, U.S. Embassy  
Sr. Mark Knez, APHIS  
Dr. José Angel Montiel, MAG  
Dr. Felix Carranza, MAG  
Dr. Roberto Bonilla, MAG  
Ing. Roberto Aguilar, MAG  
Ing. Jorge Vargas, MAG  
Dr. José F. Coronado F., CAB-MAG  
Dra. Luisa Maranda, UNA  
Dr. Antonio Solano, UNA  
Dr. Guillermo Brenes, UCR  
Dr. Johnny González, OIRSA  
Ing. Roger Guillén, CORECA  
Dr. Gerardo Vicente, Experto  
Dr. Edwin Pérez, Experto  
Dr. Harold C. Hofmann, PEGB  
Dr. Claudio V. Carvajal, PEGB  
Dr. Adonay Trejos, PEGB  
Sr. Ramón Ochoa, PEGB  
Ing. José Miguel Carrillo, PEGB  
Dr. Oscar Johanning, PEGB  
Dra. Giovanna Bulgarelli, PEGB  
MSc Wilfredo Segura, PEGB

### Estados Unidos de América

Dra. Pamela Phillips, USDA  
Dr. John Welch, USDA  
Dr. Jerry Freier, USDA

### Panamá

Dr. John Wyss, PEGB  
Dr. José Dimas Espinoza, PEGB  
Dr. Franklin Clavel, PEGB  
Dr. Steve Smith, PEGB  
Dr. Nelson Méndez, PEGB  
Dr. Abelardo De Gracia, MIDA  
Licda. Susana Ch. de Martínez, MIDA





# Conferencia-Taller: Uso del SIG para la Vigilancia Epidemiológica

Abril, 1999. San José, Costa Rica

## Presentación

El Programa para la Erradicación del Gusano Barrenador en Costa Rica le invita cordialmente a participar en la I Conferencia-Taller "Uso de Sistemas de Información Geográfica para Vigilancia Epidemiológica". El evento se llevará a cabo los días 28 y 29 de abril de 1999, en el Hotel Palma Real en San José, Costa Rica.

## Introducción

Los Sistemas de Información Geográfica (SIG) representan un gran avance en el mundo de los sistemas de información basados en las nuevas tecnologías informáticas. Los SIG permiten ingresar rápidamente información referida a un entorno geográfico.

El componente geográfico en un **Sistema de Vigilancia Epidemiológica** influirá en gran medida en el desarrollo de las acciones estratégicas; precisamente, un SIG permitirá trasladar la información (tablas, datos, etc.) a un entorno espacial (cartografía) de tal forma que se podrá analizar y explotar la información desde una nueva perspectiva. Asimismo, permitirá crear nuevos modelos de datos, que con los métodos tradicionales era difícil, si no imposible, de analizar.





De esta manera, la adaptación del SIG a los estudios epidemiológicos permitirá realizar una vigilancia epidemiológica ágil y así determinar focos de persistencia más rápidamente.

Los grandes avances en la computación (hardware y software) y el potencial que presentan los SIG para almacenar y analizar información espacial, ha llevado a que APHIS (siglas en inglés para el Servicio de Inspección Animal, Vegetal y de Salud), USDA, promueva el uso de dicha tecnología. En la última conferencia de APHIS sobre Sistemas de Información Geográfica, celebrada en julio de 1998, se recomendó entre otros aspectos, lo siguiente:

1. Los SIG deben ser reconocidos como una metodología importante en el quehacer de APHIS en los procesos de toma de decisiones.
2. La tecnología SIG debe ser parte integral en todos los niveles de APHIS.
3. Dentro de APHIS, debería de integrarse un grupo de usuarios y de soporte de SIG. Este grupo se reunirá periódicamente para discutir propuestas técnicas y conocer las aplicaciones sobre SIG que ejecutan los diferentes programas de APHIS.

Con base en las recomendaciones anteriores, el Programa para la Erradicación del Gusano Barrenador propone celebrar una reunión que agrupe expertos en SIG y epidemiología para desarrollar un sistema global de informática para el análisis de datos de las enfermedades exóticas en Costa Rica.







# PROGRAMA ERRADICACION GUSANO BARRENADOR DEL GANADO

## APLICACIONES DE SIG EN EPIDEMIOLOGIA

MSc. Wilfredo Segura López.-SIG, PEGB

### Introducción

La decisión de erradicar el gusano barrenador en Costa Rica es el resultado de un convenio firmado entre los gobiernos de Costa Rica y de Estados Unidos de América. El objetivo general del Programa para la Erradicación del Gusano Barrenador del Ganado es el de erradicar esta enfermedad para el año 1999, mejorar la producción nacional de la actividad pecuaria, ayudar a la vida silvestre y proteger la salud pública, continuar extendiendo la zona libre de gusano barrenador en Centroamérica y dar protección adicional a la industria ganadera de Estados Unidos, México y Centroamérica de una reinfestación del gusano barrenador.

El programa consta de dos departamentos principales: Administración y Operaciones de campo. El objetivo de Operaciones de Campo es implementar los sistemas de control necesarios para erradicar la mosca *Cochliomyia hominivorax* (Coquerel) del gusano barrenador y establecer y mantener un sistema de vigilancia epidemiológica capaz de detectar brotes de la plaga y su consecuente identificación.

Por otro lado, a Operaciones de Campo pertenece la unidad de Sistemas de Información Geográfica, que aparte de otras funciones, es la unidad responsable de suministrar la distribución espacial de las miasis causadas por el gusano barrenador.

El método usual para representar la distribución geográfica (espacial) de una enfermedad consiste en la elaboración de mapas. Esto es de gran valor, no solamente para identificar áreas donde existe la enfermedad, sino también en la investigación de la forma y dirección de la transmisión de las enfermedades infecciosas (Thrusfield, 1990).

Si bien el uso de Sistemas de Información Geográfica (SIG) es muy reciente en la

epidemiología, algunas funciones de esta tecnología se han aplicado durante los últimos 200 años. Por ejemplo, en 1854 John Snow elaboró para la ciudad de Londres un mapa de distribución de cólera y de los pozos de agua, llegando a la conclusión que la causa de esta epidemia se debía a la contaminación del agua (Waller, 1996).

El uso de SIG en epidemiología es tan reciente, que las diversas revistas de esta ciencia comiezan a mencionar su utilidad al inicio de la presente década (Kitron, 1994; Malone et al., 1992; Richards, 1993; Rogers and Williams, 1993; Stallones et al., 1992; Washino and Wood, 1994). Según la revista *Epidemiology Monitor*, el uso emergente de SIG en epidemiología, representó para 1995 uno de los grandes avances del desarrollo de la epidemiología (Waller, 1996).

### Objetivos

La unidad de Sistemas de Información Geográfica del Departamento de Operaciones de Campo presenta los siguientes objetivos:

#### Objetivo general

- Uso de GPS y Sistemas de Información Geográfica como herramientas complementarias en la Erradicación del Gusano Barrenador del Ganado.

#### Objetivos específicos

- Crear en ARCVIEW una base de datos, que permita uniformar el almacenamiento y posterior análisis de la diversa información que el Departamento de Operaciones de Campo esta recolectado en todo el país.
- Desarrollar una herramienta que permita realizar una vigilancia epidemiológica agil, y así determinar focos de persistencia más rápidamente.





- Elaborar un modelo preliminar que permita determinar las áreas potenciales con mayor riesgo de incidencia del Gusano Barrenador del Ganado.
- Diseñar la estructura de una base de datos epidemiológica, que se proyecte como base para futuros estudios de otras enfermedades y/o pestes.

### Área de estudio

Debido a que el gusano barrenador está presente en todo el territorio nacional, el área de trabajo abarca toda la República de Costa Rica.

### Metodología

La información que integra la base de datos es recolectada por el diverso personal que integra el Departamento de Operaciones de Campo. De esta manera, funcionarios de la Oficina Central, Centro de Identificación Nacional (CIN), Control Técnico y Epidemiología utilizan GPS para registrar las coordenadas de las trampas, puntos ciegos, así como cada una de las muestras que se recolectan en todo el territorio nacional.

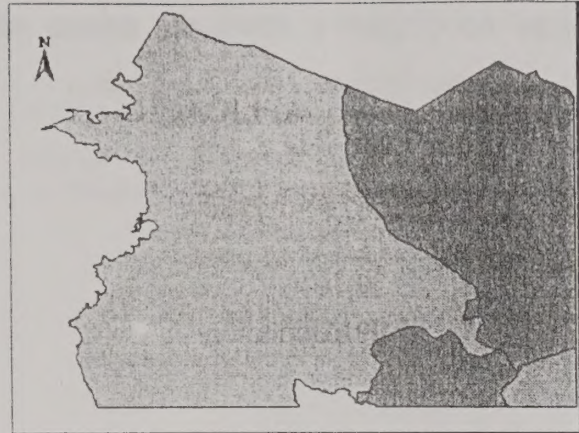
Por otro lado, el software que se utiliza para almacenar, procesar y analizar dicha información es *ARCVIEW 3.0*, junto con la extensión *SPATIAL ANALYST*.

### Resultados preliminares

A continuación se presentan algunos resultados preliminares elaborados a partir de *ARCVIEW*, los cuales presentan un gran valor en el seguimiento que se lleva a cabo para la erradicación del gusano barrenador.

#### 1. Ubicación de trampas

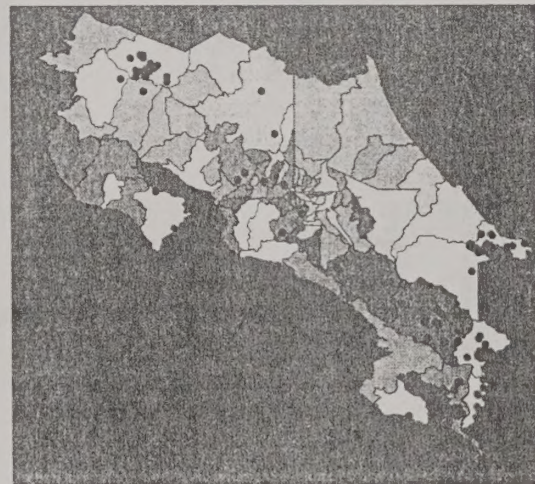
La ubicación exacta de las trampas es muy importante, ya que los datos asociados a éstas (moscas estériles, moscas fértiles, otros dípteros, etc), representan la base para un control adecuado de la dispersión de moscas estériles que se realiza diariamente.



#### 2. Distribución de casos positivos y negativos

A continuación se muestran varios mapas que indican la distribución de casos positivos y negativos. Tales distribuciones pueden representar algún tópico o tema específico que se desea representar espacialmente.

##### 2.1 Mapa de cantones y distribución de casos positivos:

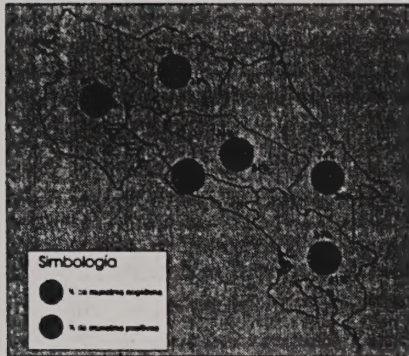




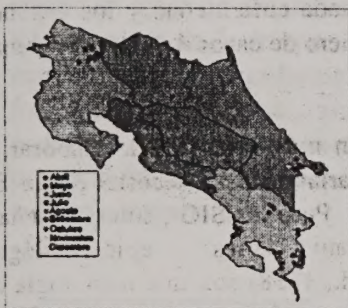




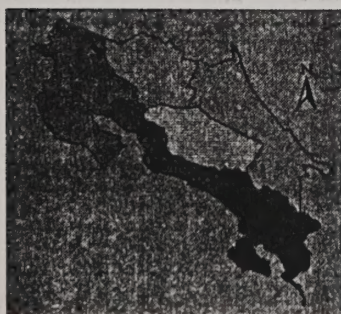
## 2.2 Mapa de distribución (porcentaje) de casos positivos y negativos según regiones geográficas:



## 2.3 Mapa de casos positivos a través del tiempo (meses):



## 2.4 Mapa de casos positivos, que fueron causados por la mordedura de vampiros:







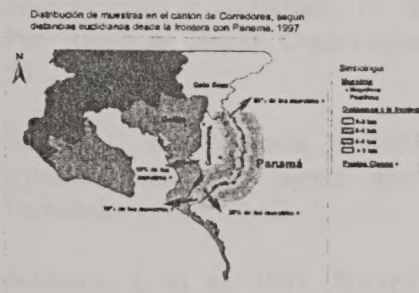
### 3. Ubicación de puntos ciegos

La ubicación de puntos ciegos nos permitirá entre otras cosas, trabajar con mayor coordinación con los funcionarios del Programa para la Erradicación del Gusano Barrenador de Panamá.



### 4. Distancias euclidianas a partir de la frontera con Panama

Por medio del comando *FIND DISTANCE* se ha creado un mapa de distancias (con intervalo de 3 KM) a partir de la frontera con Panamá. Este mapa muestra que conforme nos acercamos a la frontera con Panamá, aumentan los casos positivos. Esta distribución espacial, es un producto útil a la hora de buscar una explicación a dicho comportamiento.



### Resultados esperados

Aparte de los resultados mencionados anteriormente, las diversas funciones presentes en ARCVIEW nos permiten crear otro tipo de información espacial. De esta manera, se pretende obtener:

a) un mapa preliminar de temperatura, para lo cual se registrarán temperaturas a lo largo y

ancho del territorio nacional; además se utilizará información disponible en el Instituto Meteorológico Nacional. La creación propiamente dicha de este mapa se realizará con el comando *INTERPOLARTE SURFACE*

b) un mapa que ubique los centros ganaderos (subastas, ferias, etc.), y clínicas veterinarias de todo el país, con el fin de reforzar el plan de vigilancia y cuarentena.

c) un modelo preliminar que determine los sitios potenciales con mayor riesgo de infestación del gusano barrenador; para lo cual se considerará primeramente las variables: tipo de suelo, temperatura y cobertura vegetal del suelo.

### Discusión

Los mapas de uso común en la epidemiología son cualitativos y cuantitativos. Los primeros indican la localización sin especificar la cantidad de una determinada enfermedad y los segundos muestran el número de casos de una determinada enfermedad.

Tales mapas son muy sencillos de elaborar, de hecho no necesariamente se necesita de un SIG para realizarlos. Pero los SIG, como lo señalan muchas organizaciones epidemiológicas (Behbehani et al., 1998) son una tecnología que ofrece una oportunidad única para guiar los problemas tradicionales que han estado asociados con la recolección, validación y manejo de datos.

Además, los SIG son capaces de visualizar y combinar información de diferentes sectores del país, tales como investigación epidemiológica, educación, infraestructura vial y clima entre otros; lo cual permite un análisis más acertado de los fenómenos epidemiológicos.

### Conclusiones

El Sistema de Información Geográfica nos ha permitido hasta la fecha:

1) Unificar la diversa información que el Programa para la Erradicación del Gusano Barrenador está recolectando en todo el país.





2) Utilizar información georeferenciada de otras instituciones (MAG, UNA, etc.), lo que ha fortalecido la toma de decisiones.

3) Representar la información de una forma más gráfica y rápida, lo que agiliza y facilita el análisis de la misma.

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[www.who.ch/programmes/ctd/gisact.htm](http://www.who.ch/programmes/ctd/gisact.htm).

Kitron, U et al. 1994. Geographic Information System in malaria surveillance: mosquito breeding and imported cases in Israel, 1992. In: American Journal of Tropical Medicine and Hygiene, 50(5): 550-556.

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Richards, F. 1993. Use of Geographic Information System in control programs for onchocercosis in Guatemala. In: Bulletin of the Pan American Health Organization, 27(1): 52-55.

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Thrusfield, M. 1990. Epidemiología Veterinaria. Editorial ACRIBIA, S.A. Zaragoza, España. 339 p.

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# **PROYECTO PILOTO PARA LA INTEGRACIÓN DE LOS SISTEMAS DE VIGILANCIA EPIDEMIOLOGICA DEL PEGBG Y EL MAG EN LA REGION CHOROTEGA DE COSTA RICA**

Giovanna Bulgarelli Jiménez, MV, Msc  
Supervisora de Area, Región Norte, PEGB

Una vez concretada la fase de erradicación de *C. hominivorax* en Costa Rica, la fase de vigilancia epidemiológica de la enfermedad quedará a cargo de la Dirección de Salud Animal del Ministerio de Agricultura y Ganadería. Con el fin de facilitar que el MAG asuma esta función, y de fortalecer los servicios veterinarios oficiales, se crea el proyecto piloto para integrar los sistemas de vigilancia epidemiológica utilizados por ambos grupos.

El proyecto inicia en forma piloto en la región Chorotega<sup>1</sup>, donde las autoridades locales del PGB y del MAG consideran prioritario mejorar la vigilancia epidemiológica de enfermedades veterinarias de interés nacional e internacional, no solo en la zona si no en el país.

Durante el año 1998 el PGB implementó un sistema de vigilancia mediante el cual se cubrió más del 80% del territorio nacional, y se visitó un promedio de 5000 fincas productoras de ganado bovino, principalmente. El sistema se basó en la visita mensual de 5 a 10 fincas, dentro de áreas de 25 km<sup>2</sup> denominadas cuadrículas. Debido a la realidad encontrada en cada cuadrícula, todas las categorías de producción bovina, equina, porcina, ovina y caprina fueron consideradas en la selección de fincas.

La visita mensual de las fincas generó un reporte, en el que se registró presencia o ausencia de animales con gusaneras, así como el comportamiento de prácticas sanitarias y de manejo que favorecen la presentación de casos de gusanera por *C. hominivorax*. Además, se llevó a cabo una campaña de educación y concientización del ganadero y personal asociado, que asegurara la revisión periódica del ganado, el tratamiento preventivo de heridas, la recolección y reporte de casos de gusanera, y el transporte de animales sin gusanos.

La Dirección de Salud Animal ha orientado la vigilancia epidemiológica a enfermedades exóticas y zoonosis de interés nacional e internacional, como son: enfermedades vesiculares, rabia paralítica bovina, tuberculosis, brucelosis, encefalopatía espongiforme bovina, encefalitis equina del este, oeste y venezolana, peste porcina clásica y africana, influenza aviar y Newcastle.

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<sup>1</sup> Según División Administrativa Costarricense corresponde a la provincia de Guanacaste.







La vigilancia epidemiológica aplicada a estas enfermedades se torna pasiva o activa, dependiendo de los recursos disponibles por la Dirección de Salud Animal. Es así como la vigilancia actual, involucra aspectos educativos y de concientización para el reporte de casos de enfermedad y muerte, recolección de muestras y confirmación de diagnósticos, muestreos planificados, monitoreo de fincas centinela seleccionadas según análisis de riesgo y control de movilización de animales.

La integración de los sistemas de vigilancia epidemiológica comprende unicamente, la unificación de funciones educativas y de concientización de productores, de reporte de casos sospechosos de enfermedad y de recolección y envío de muestras. Lo anterior se basará en el sistema de visita a fincas por cuadrículas, de tal forma que 5 fincas visitadas por el PEGB en el año 1998 continuen siendo visitadas mensualmente y 3 fincas no visitadas regularmente por el PEGB se visiten esporádicamente luego de ser seleccionadas al azar.

La visita será realizada por el personal técnico del PGB, quien tendrá a cargo la recolección primaria de información y el reporte de casos sospechosos de enfermedad, mediante la utilización de una encuesta epidemiológica orientada a las enfermedades de interés oficial y C. hominivorax. Esta información pasará diariamente al Médico Veterinario oficial, quien tendrá a su cargo la recolección secundaria de información, durante la atención y seguimiento de denuncias. Además, los veterinarios tendrán que mantener activas las otras funciones de vigilancia a cargo de la Dirección de Salud Animal.

La información será almacenada y analizada con software Epiinfo y SIG. Los resultados del análisis serán distribuidos al personal involucrado como retroalimentación del sistema, para la interpretación y toma oportuna de decisiones, y para promover la motivación del personal involucrado.

Los Médicos Veterinarios en práctica privada, los propietarios o administradores de subastas, mataderos y otros serán involucrados como colaboradores de visita mensual, para obtención de información asociada a reporte de casos de enfermedad y movimiento de ganado. Se promoverán visitas individualizadas por parte de los Médicos Veterinarios oficiales y del PGB a estos segmentos, así como la organización de actividades de educación.

Los recursos actuales del proyecto contemplan recursos de la Dirección de Salud Animal del MAG y del PEGB; sin embargo, a corto plazo la vigilancia epidemiológica planteada quedará sujeta a los recursos del MAG, por lo que al completarse el período de evaluación (seis meses) del proyecto, deberán realizarse los ajustes necesarios para asegurar el funcionamiento y expansión del mismo con recursos humanos y materiales limitados a las posibilidades del MAG.





# Glossary of GIS Terms<sup>1</sup>

**accuracy** - Degree of conformity with a standard. Accuracy relates to the quality of a result and is distinguished from precision which relates to the quality of the operation by which the result is obtained.

**adjustment** - Process designed to minimize inconsistencies in measured or computed quantities by applying derived corrections to compensate for random or accidental errors.

**aerotriangulation (or bridging)** - The process of developing a network of horizontal and (or) vertical positions from a group of known positions utilizing direct or indirect measurements from aerial photographs and mathematical computations.

**algorithm** - A mathematical equation used to process and to classify image data such that pixel values are assigned to a discrete class.

**albedo** - The ratio of light reflected by an object to that received.

**aspect** - The direction that a surface slopes.

**attribute** - Information that describes a feature of interest.

**attribute database** - A collection of information about an area of interest.

**azimuth** - Horizontal direction reckoned clockwise from the meridian plane.

**azimuth angle** - The angle defined by the intersection of a map's central line of projection with any meridian.

**band** - A set of values for a specific portion of the electromagnetic spectrum of reflected light or emitted heat. Remote sensing devices commonly collect images in discrete bands, such as visible, red, green, blue and the invisible near-infrared.

**bench mark** - Relatively permanent material object, natural or artificial, bearing a marked point whose elevation above or below an adopted datum is known.

**brightness** - The physical property indicating how much electromagnetic radiation is being reflected or radiated by a chosen point.

**buffer zone** - A border area that separates or surrounds a designated area.

**cadastre** - An official register of the ownership, extent, and value of real property in given area, used as a basis of taxation.

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<sup>1</sup> Terms and definitions were obtained from many sources; however, the most used source was:

Anonymous. 1987. Large-scale mapping guidelines. Reston, Virginia:  
American Society for Photogrammetry and Remote Sensing and the  
American Congress on Surveying and Mapping, vi + 47 pp.





**calibrate** - Same as georeference.

**cartography** - Science and art of making maps and charts. The term may be taken broadly as comprising all the steps needed to produce a map: planning, aerial photography, field surveys, photogrammetry, editing, color separation, and multicolor printing.

**C-factor** - Empirical ratio between flight height and contour interval used to indicate the capability of photogrammetric systems. (C-factor multiplied by contour interval desired equals flight height of aerial photography.) C-factor, unless otherwise indicated, is based on the use of 6-inch focal length lenses with a 9- by 9-inch film format.

**classification** - The process of assigning the image brightness value of each pixel to a discrete category

**color separation** - Process of preparing a separate drawing, engraving, or negative for each color required in the printing production of a map or chart.

**compilation** - Preparation of a new or revised map or chart, or portion thereof, from existing maps, aerial photographs, field surveys, and other sources.

**contour** - Imaginary line on the ground, all points of which are at the same elevation above or below a specified datum.

**contour interval** - Difference in elevation between two adjacent contours.

**control, mapping** - Points of established position or elevation, or both, which are used as fixed references in positioning and correlating map features. Fundamental control is provided by stations in the national networks of triangulation and traverse (horizontal control) and leveling (vertical control). Usually it is necessary to extend geodetic surveys, based on the fundamental stations, over the area to be mapped, to provide a suitable density and distribution of control points. Supplemental control points are those needed to relate the aerial photographs used for mapping with the system of ground control. These points must be positively photoidentified; that is, the points on the ground must be positively correlated with their images on the photographs.

**control point** - Points used to establish map coordinate control for un-georeferenced objects.

**control station** - Point on the ground whose position (horizontal or vertical) is known and can be used as a base for additional survey work.

**coordinates, origin of** - A defined point in a system of coordinates which serves as a reference point from which the system coordinates are measured.

**coordinates, origin of** - Point in a system of coordinates which serves as a zero point in computing the systems elements or in prescribing its use.

**coregistration** - The condition in which associated raster and/or vector objects overlay each other with correct orientation and geometry so that corresponding internal features align.





**crab (aerial photography)** - The condition caused by failure to orient the camera with respect to the track of the airplane. In vertical photography, crab is indicated by the edges of the photographs not being parallel to the intended ground track of the aircraft.

**culture** - Features constructed by man that are under, on, or above the ground which are delineated on a map. These include roads, trails, buildings, canals, and sewer systems. In a broad sense, the term also applies to all names, other identification, and legends on a map.

**database** - A group of computer files and programs that are related to tabular data sets.

**datum (Pl. datums)** - In surveying, a reference system for computing or correlating the results of surveys. There are two principal types of datums: vertical and horizontal. A vertical datum is a level surface to which heights are referred. In the United States, the generally adopted vertical datum for leveling operations is the National Geodetic Vertical Datum of 1929. The horizontal datum, used as a reference for position, is defined by: the latitude and longitude of an initial point, the direction of a line between this point and a specified second point, and two dimensions which define the spheroid.

**datum, national geodetic vertical** - See National Geodetic Vertical Datum of 1929.

**decision rule** - An equation or algorithm that is used to classify image data, after signatures have been created. The decision rule is used to process the data file values based upon the signature statistics.

**diazo process** - A dry, rapid and inexpensive method for reproducing documents.

**digitize** - To convert analog data, such as data displayed in a map, to a numeric or digital form. A digitizing tablet is often used to perform this conversion.

**displacement** - Any shift in the position of an image on a photograph due to tilt during photography, scale changes in the photographs, and relief of the area photographed.

**electronic distance measuring (EDM) devices** - Instruments that measure the phase difference between transmitted and reflected or retransmitted electromagnetic waves of known frequency, or that measure the roundtrip transit time of a pulsed signal, from which distance is computed.

**elevation** - Vertical distance of a point above or below a reference surface or datum.

**emulsion** - Suspension of a light-sensitive silver salt (especially silver chloride or silver bromide) in a colloidal medium (usually gelatin), which is used for coating photographic films, plates, and papers. Types of photographic emulsions commonly used are panchromatic (black and white), color negative, color positive, color infrared, and black- and- white infrared.

**engineering map** - See map, engineering.

**enzootic** - The continued and constant presence of a disease organism in animals other than human beings in a geographic area over a long period of time.





**feature separation** - Process of preparing a separate drawing, engraving, or negative for selected types of data in the preparation of a map or chart.

**flood control map** - See map, flood control.

**flood plain** - Belt of low flat ground bordering a stream channel that is flooded when runoff exceeds the capacity of the stream channel.

**fly leveling** - Leveling in which some of the restrictions of precise leveling, such as limiting length of sight, balancing backsights and foresights, etc., are relaxed to obtain elevations of moderate accuracy more rapidly.

**focal length** - A general term for the distance between the rear node of a lens and the point where the image of an infinitely distant object comes into critical focus.

**fog (photographic)** - The visual density reducing light transmission caused by the base material (usually polyester) and the emulsion of the photographic medium.

**frequency distribution of image brightness values** - This is the number of times a value occurs across a range of possible values.

**generalization** - Process of bringing a raster, vector, or CAD object into alignment with some geographic coordinate system.

**geodesy** - Science concerned with the measurement and mathematical description of the size and shape of the Earth and its gravitational field. Geodesy also includes the large-scale extended surveys for determining positions and elevations of points, in which the size and shape of the Earth must be taken into account.

**GPS** - Global Positioning System. A network of radio-emitting satellites deployed by the U.S. Department of Defense. Ground-based GPS receivers can automatically derive accurate surface coordinates for all kinds of GIS, mapping, and surveying data collection.

**graticule** - Network of parallels and meridians on a map or chart.

**grid** - Network of uniformly spaced parallel straight lines intersecting at right angles. When superimposed on a map, it usually carries the name of the projection used for the map- that is, Lambert grid, transverse Mercator grid, universal transverse Mercator grid. However, care must be taken not to confuse a projection grid with the underlying network of geographic meridians and parallels generated by the projection.

**ground truthing** - The acquisition of information about a study area from field work.

**halftone** - A picture in which the gradations of light are obtained by the relative darkness and density of tiny dots produced by photographing the subject through a fine screen.

**hypsographic map** - See map, hypsographic.





**imagery** - Visible representation of objects and (or) phenomena as sensed or detected by cameras, infrared and multispectral scanners, radar, and photometers. Recording may be on photographic emulsion (directly as in a camera or indirectly after being first recorded on magnetic tape as an electrical signal) or on magnetic tape for subsequent conversion and display on a cathode ray tube.

**land use map** - See map, land use.

**latitude** - Angular distance, in degrees, minutes, and seconds, of a point north or south of the Equator.

**lens distortion** - Lens aberrations shifting the position of images off the axis in which objects at different angular distances from the axis undergo different magnifications.

**leveling** - Surveying operation in which elevations of objects and points are determined relative to a specified datum.

**line copy (line drawing)** - Map copy suitable for reproduction without the use of a screen; a drawing composed of lines as distinguished from continuous-tone copy.

**longitude** - Angular distance, in degrees, minutes, and seconds, of a point east or west of the Greenwich meridian.

**loran** - A navigational, position-determination system based on radio transmission travel times from pairs of master and slave broadcast locations.

**map** - Graphic representation of the physical features (natural, artificial, or both) of a part or the whole of the Earth's surface, by means of signs and symbols or photographic imagery, at an established scale, on a specified projection, and with the means of orientation indicated.

**map, engineering** - Map showing information that is essential for planning an engineering project or development and for estimating its cost. It usually is a large-scale map of a small area or of a route. It may be entirely the product of an engineering survey, or reliable information may be collected from various sources for the purpose, and assembled on a base map.

**map, flood control** - Map designed for studying and planning flood control projects in areas subject to flooding.

**map, hypsographic** - Map showing relief with elevations referred to a datum.

**map, land use** - Map showing the various purposes for which land is being used.

**map, line** - Map composed of lines and other symbols as distinguished from imagery maps.

**map, orthophotographic** - Map produced by assembling orthophotographs at a specified uniform scale in a map format.





**map, planimetric** - Map that presents only the horizontal positions for features represented; distinguished from a topographic map by the omission of relief in measurable form. The features usually shown on a planimetric map include rivers, lakes, and seas; mountains, valleys, and plains; forest and prairies; cities, farms, transportation routes, and public utility facilities; and political and private boundary lines. A planimetric map intended for special use may present only those features essential to the purpose to be served.

**map, thematic** - Map designed to provide information on a single topic, or group of topics, such as geology, rainfall, population.

**map, topographic** - Map that presents the horizontal and vertical positions of the features represented; distinguished from a planimetric map by the addition of relief in measurable form.

**map projection** - Systematic representation of all or part of the surface of a round body, especially the Earth, on a plane. This usually includes lines delineating meridians and parallels.

**map series** - Family of maps conforming generally to the same specifications and designed to cover an area or a country in a systematic pattern.

**meridian** - Great circle on the surface of the Earth passing through the geographical poles and any given point on the Earth's surface. All points on a given meridian have the same longitude.

**metes and bounds** - Method of describing the boundary (bounds) of land by a series of lines usually identified by measure of length (metes) and direction from the previous line.

**metric system** - Decimal system of weights and measures based on the meter as a unit length and the kilogram as a unit mass.

**minimum distribution angle** - A classification process in which values from two or more data sets are transformed to produce a set of continuous measures of biophysical conditions rather than as data separated into categories.

**modeling** - A logical sequence of analytical operations used to produce information. Modelling allows you to create new classes from existing classes and create a small set of images, or perhaps even a single image, which contains many types of information about a scene.

**monument (surveying)** - Permanent physical structure marking the location of a survey point. Common types of monuments are inscribed metal tablets set in concrete posts, solid rock, or parts of buildings; distinctive stone posts; and metal rods driven in the ground.

**National Geodetic Vertical Datum of 1929** - Reference surface established by the U.S. Coast and Geodetic Survey in 1929 as the datum to which relief features and elevation data are referenced in the conterminous United States; formerly called "mean sea level of 1929."

**neatline** - Line separating the body of a map from the map margin. On a standard U.S. Geological Survey quadrangle map, the neatlines are the meridians and parallels delimiting the quadrangle.





**normalizing** - An adjustment in the distribution of cell values resulting in a symmetrical ("bell curve") distribution of image data.

**origin of coordinates** - Point in a system of coordinates that serves as a zero point in computing the system's elements or in prescribing its use.

**orthophotograph** - Photograph having the properties of an orthographic projection. It is derived from a conventional perspective photograph by simple or differential rectification so that image displacements and scale differences caused by camera tilt and terrain relief are removed.

**orthophotographic map** - Map produced by assembling orthophotographs at a specified uniform scale in a map format.

**orthophotomap** - Orthophotographic map with contours and cartographic treatment, presented in a standard format, and related to standard reference systems.

**orthophotomosaic** - Assembly of orthophotographs forming a uniform-scale mosaic.

**overlap** - The amount by which one photograph overlaps another, customarily expressed as a percentage. The overlap between aerial photographs in the same flightline is called the endlap, and the overlap between photographs in adjacent parallel flightlines is called the sidelap.

**overlay** - Printing or drawing on a transparent or translucent medium intended to be placed in register on a map or other graphic which depicts information which does not appear on the base material or which requires special emphasis.

**overprint** - New material printed on a map or chart to show data of importance or special use, in addition to those data originally printed.

**parallel** - A circle on the figure of the Earth, formed by the intersection of the Earth's figure with a plane parallel to the plane of the Equator. This line is identified by its latitude. The equator is also a parallel.

**pass point** - A point whose horizontal and (or) vertical position is determined from photographs by photogrammetric methods and which is intended for use as a control point in the orientation of the photographs.

**photogrammetry** - Science or art of obtaining reliable measurements or information from photographs or other sensing systems.

**photoindex** - An assembly of photographs in their proper relative positions, generally annotated and copied at a reduced scale.

**photomap (photographic map)** - Map made by adding marginal information, descriptive data, and a reference system to a photograph or assembly of photographs.

**pixel** - The smallest element of an image that can be individually processed in a video display system.





**planimetric map** - A map designed to show the horizontal positions of features and vertical information is ignored.

**planimetry** - Plan details of a map- those having no indications of relief or contour.

**public land survey system** - Public lands are subdivided by a rectangular system of surveys established and regulated by the Bureau of Land Management. The standard format for subdivision is by townships measuring 6 miles (480 chains) on a side. Townships are further subdivided into 36 numbered sections of 1 square mile (640 acres) each.

**quadrangle** - Four-sided area, bounded by parallels of latitude and meridians of longitude used as an area unit in mapping (dimensions are not necessarily the same in both directions).

**raster data** - Data that is organized in a matrix of columns and rows.

**rectification, differential** - The process of scanning and reprojecting a photograph onto a plane in differential elements to remove displacements due to tilt and relief. The process may be accomplished by any one of a number of instruments developed specifically for the purpose.

**rectification, simple** - The process of projecting a photograph onto a horizontal plane by means of a rectifier to remove displacements due to tilt of the camera.

**relief** - Elevation variations of the land or sea bottom.

**representative fraction** - Scale of a map or chart expressed as a fraction or ratio that relates unit distance on the map to distance measured in the same unit on the ground.

**scale** - Ratio of the distance between two points on a map and the earth distance between the same two points. Relationship existing between a distance on a map, chart, or photograph and the corresponding distance on the Earth.

**scribing** - Removal of portions of a photographically opaque coating from a transparent base with engraving tools.

**section** - Unit of subdivision of a township; normally a quadrangle 1 mile square with boundaries conforming to meridians and parallels within established limits, and containing 640 acres as nearly as practicable.

**sidelap** - See overlap.

**spectral signature** - A collection of pixel values that represent a potential feature class.

**spot elevation** - Point on a map or chart whose height above a specified datum is noted, usually by a dot or a small sawbuck and elevation value. Elevations are shown, on a selective basis, for road forks and intersections, grade crossings, summits of hills, mountains and mountain passes, water surfaces of lakes and ponds, stream forks, bottom elevations in depressions, and large flat areas.





**state plane coordinate systems** - Rectangular coordinate systems established beginning in the 1930's by the U.S. Coast and Geodetic Survey, providing one or more zones for each State based on a specific map projection and origin for each zone.

**stereocompilation** - Production of a map or chart manuscript from aerial photographs and geodetic control data by means of photogrammetric instruments.

**stereoplotter** - Instrument for plotting a map by observation of stereomodels formed by pairs of photographs.

**stereoscopic** - Pertaining to the use of binocular vision for observation of a pair of overlapping photographs or other perspective views, giving the impression of depth.

**supervised classification** - A type of automatic multi-spectral image interpretation in which the user supervises feature classification by setting up prototypes (collections of sample points) for each feature, class, or land cover to be mapped.

**target** - The distinctive marking or instrumentation of a ground point to aid in its identification on a photograph. A target is so arranged and placed as to form a distinctive image over a geodetic or other control-point marker, on a property corner or line, or at the position of an identifying point above an underground facility or feature.

**thematic map** - See map, thematic.

**thematic mapper** - A sensing device on the Landsat satellite that scans and stores seven individual images in spectral bands ranging from the blue wavelengths up to those in the thermal infrared.

**topographic map** - See map, topographic.

**topography** - Configuration (relief) of the land surface; the graphic delineation or portrayal of that configuration in map form, as by contour lines; in oceanography the term is applied to a surface such as the sea bottom or a surface of given characteristics within the water mass.

**township** - Unit of survey of the public lands of the United States, normally a square area approximately 6 miles on a side with boundaries conforming to meridians and parallels within established limits, containing 36 sections. Also, in certain parts of the country, the term designates a minor governmental subdivision.

**training site** - A location on the ground used to represent a specific feature class.

**traverse** - Sequence of lengths and directions of lines connecting a series of stations, obtained from field measurements, and used in determining positions of the stations.

**triangulation** - Method of extending horizontal position on the surface of the Earth by measuring the angles of triangles and the included sides of selected triangles.

**trilateration** - Method of surveying wherein the lengths of the triangle sides are measured, usually by electronic methods, and the angles are computed from the measured lengths. Compares with triangulation.





**Universal Transverse Mercator (UTM) grid** - Rectangular coordinate system based on the UTM projection, a specific form of the Transverse Mercator Projection which consists (basically) of 6°- wide zones of longitude extending from latitudes 84° N. and 80° S.

**vector data** - Refers to data that represents physical forms (elements) such as points, lines, and polygons.





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<http://www.idcr.ca/books/focus/766/read2.html>

### *Journals and Magazines*

*Cartography and Geographic Information Systems*, since 1973 (formerly *The American Cartographer*), quarterly, American Congress on Surveying and Mapping. ISSN 1050-9844.

*Computers and Geosciences: An International Journal*, since 1974, 8 issues per year, Pergamon Press. ISSN 0098-3004.

*Geographical Systems: The International Journal of Geographical Information, Analysis, Theory, and Decision*, since 1994, Gordon and Breach Science Publishers.

*GeoInfo Systems*, since 1991, 10 issues per year, Aster Publishing Co.

*Geomatica* (former *CISM/ACSGS Journal*), since 1945, quarterly, Canadian Institute of Geomatics. ISSN 1195-1036.

*GIM: International Journal for Surveying, Mapping, and Applied GIS*, since 1987, bimonthly, GITC. ISSN 0928-1436.

*GIS Asia/Pacific*, since 1985, bimonthly, GIS World Inc.

*GIS Europe: Europe's Geographic Information Systems Magazine*, since 1992, 10 issues per year, Longman Group (Longman Geoinformation). ISSN 0926-3403.

*GIS World*, since 1988, 10 issues per year, GIS World Inc. ISSN 0897-5507.

*International Journal of Geographical Information Systems*, since 1986, bimonthly, Taylor and Francis. ISSN 0143-1161.

*Journal of Urban and Regional Information Systems*, Urban and Regional Information Systems Association.

*Mapping Awareness* (formerly *Mapping Awareness and Integrated Spatial Information Systems*: in the United Kingdom and Ireland), since 1987, 10 issues per year, Longman Group Inc. ISSN 0954-7126.

*Surveying and Land Information Systems*, since 1940, quarterly, American Congress on Surveying and Mapping. ISSN 0039-6273.





## GIS Software

This is a selected list of GIS software packages with contact information. Given the rapidly changing nature of GIS software in terms of price and function, no attempt has been made to describe and/or compare these packages. The information given here is based on the "GIS Package List" maintained by Oliver Weatherbee. Weatherbee's list is more comprehensive than the information given here and includes descriptions of the packages and reviewer comments. It can be obtained through the internet at <http://www.laum.uni-hannover.de>. The reader is also referred to the vendors directly for their latest information.

This author, Steven Reader, accepts no responsibility for any errors in this list, nor endorses any of the products listed in any way.

Name: ARC/INFO, pcARC/Info, ArcCAD, ArcView  
Type: Commercial  
Operating Systems: UNIX, DOS and Windows  
Company: Environmental Systems Research Institute, Inc. (ESRI)  
380 New York Street  
Redlands, CA, USA 92373  
Tel: 909 793 2853  
Fax: 909 793 2853

Name: ATLAS-GIS  
Type: Commercial  
Operating Systems: DOS and Windows  
Company: Strategic Mapping, Inc.  
4030 Moorpark Ave, Suite 250  
San Jose, CA, USA 95117  
Tel: 408 985 7400  
Fax: 408 985 0859

Name: CARIS  
Type: Commercial  
Operating Systems: UNIX, Windows  
Company: Universal Systems Ltd  
270 Rookwood Avenue  
PO Box 3391, Station B  
Fredericton, NB, Canada  
Tel: 506 458 8533  
Fax: 506 459 3849

Name: CISIG  
Special Note: A low-cost GIS that is distributed with the digitizing package ROOTS. Lower cost for developing countries (US\$200).  
Operating Systems: DOS (?)

Company: GIS Services  
Conservation Planning and Technical Cooperation  
Conservation International  
1015 18th Street, NW, Suite 1000  
Washington, DC, USA 20036  
Tel: 202 429 5660  
Fax: 202 887 0193





Name: GENAMAP  
Type: Commercial  
Operating Systems: UNIX  
Company: Genasys II Pty. Ltd  
33 Berry Street, 13th Level  
N. Sydney, New South Wales, Australia 2060  
Tel: 61 2 954 0022  
Fax: 61 2 954 9930

Name: GRASS  
Type: Public Domain (freeware)  
Operating Systems: UNIX (Mac under development)  
FTP site: moon.cecer.army.mil (129.229.20.254) in /grass directory

Name: IDRISI  
Type: Commercial (low cost)  
Operating Systems: DOS (Windows version due May, 1995)  
Company: Graduate School of Geography  
Clark University  
950 Main St  
Worcester, MA, USA 01610  
Tel: 508 793 7526  
Fax: 508 793 8842

Name: ILWIS  
Type: Commercial  
Operating Systems: DOS (?)  
Company: ILWIS  
International Institute for Aerospace Survey and Earth Sciences  
350, Boulevard 1945  
PO Box 6  
7500 AA Enschede, The Netherlands  
Tel: 31 53 874337  
Fax: 31 53 874484

Name: Intergraph MGE  
Type: Commercial  
Operating Systems: UNIX, Macintosh and Windows NT  
Company: Intergraph Corp  
Mapping Sciences Division  
Huntsville, AL, USA 35894  
Tel: 205 730 2700

Name: MAPGRAFIX  
Type: Commercial  
Operating Systems: Macintosh  
Company: ComGrafix, Inc.  
620 E Street  
Clearwater, FL, USA 34616  
Phone: 813 443 6807  
Fax: 813 443 7585





Name: MAPINFO  
Type: Commercial  
Operating Systems: UNIX, Macintosh and Windows  
Company: MapInfo Corp  
One Global View  
Troy, NY, USA 12180  
Tel: 518 285 6000  
Fax: 518 285 6060

Name: MOSS  
Type: Public Domain: PC version via FTP, UNIX version US\$500  
Operating Systems: DOS, UNIX. (DOS version is several revs. behind UNIX and no longer updated)  
FTP: (DOS version only) ftp.csn.org (128.138.213.21) in /cogs/moss  
Company: Bureau of Land Management Service Center  
Denver Federal Center  
Denver, CO, USA 80225

Name: OzGIS  
Special note: This package can be obtained as shareware by FTP for demonstration purposes. Actual cost of software is approx. US\$500  
Operating Systems: DOS and Windows  
FTP: ftp.cica.indiana.edu in /pub/pc/win3/misc.  
Company: The Clever Company  
QMDD Box 6108  
Queanbeyan, Australia 2620

### GIS Internet Resources

The global computer network known as the Internet is rapidly becoming a major resource for GIS information, data, software, and expertise. The list of sites below is a selection intended to provide starting points for exploring GIS resources on the Internet. These resources are growing daily and should be monitored periodically. No attempt is made here to explain the different modes of access of these resources. The reader is referred to any introductory book on the Internet for this information.

*Useful World Wide Web (WWW) Servers* All these sites are useful starting points for GIS resource exploration on the WWW.

<http://www.geo.ed.ac.uk> — University of Edinburgh, Scotland  
<http://info.er.usgs.gov> — United States Geological Survey  
<http://www.laum.uni-hannover.de> — University of Hannover, Germany  
<http://www.tis.psu.edu> — Penn State University, USA  
<http://www.iko.unit.no> — Norwegian Institute of Technology  
<http://deathstar.rutgers.edu> — Rutgers University, USA  
<http://www.ncgia.ucsb.edu> — National Center for Geographic Information and Analysis, USA

All the above sites contain pointers to other GIS-oriented sites. To get a fairly comprehensive list of GIS-oriented WWW home pages, use anonymous ftp to retrieve the following:

<ftp://gis.queensu.ca/pub/gis/docs/gissites.txt> — Michael McDermott's list

A GIS frequently-asked-questions (FAQ) is maintained at the following location:

<http://www.census.gov> — United States Bureau of the Census

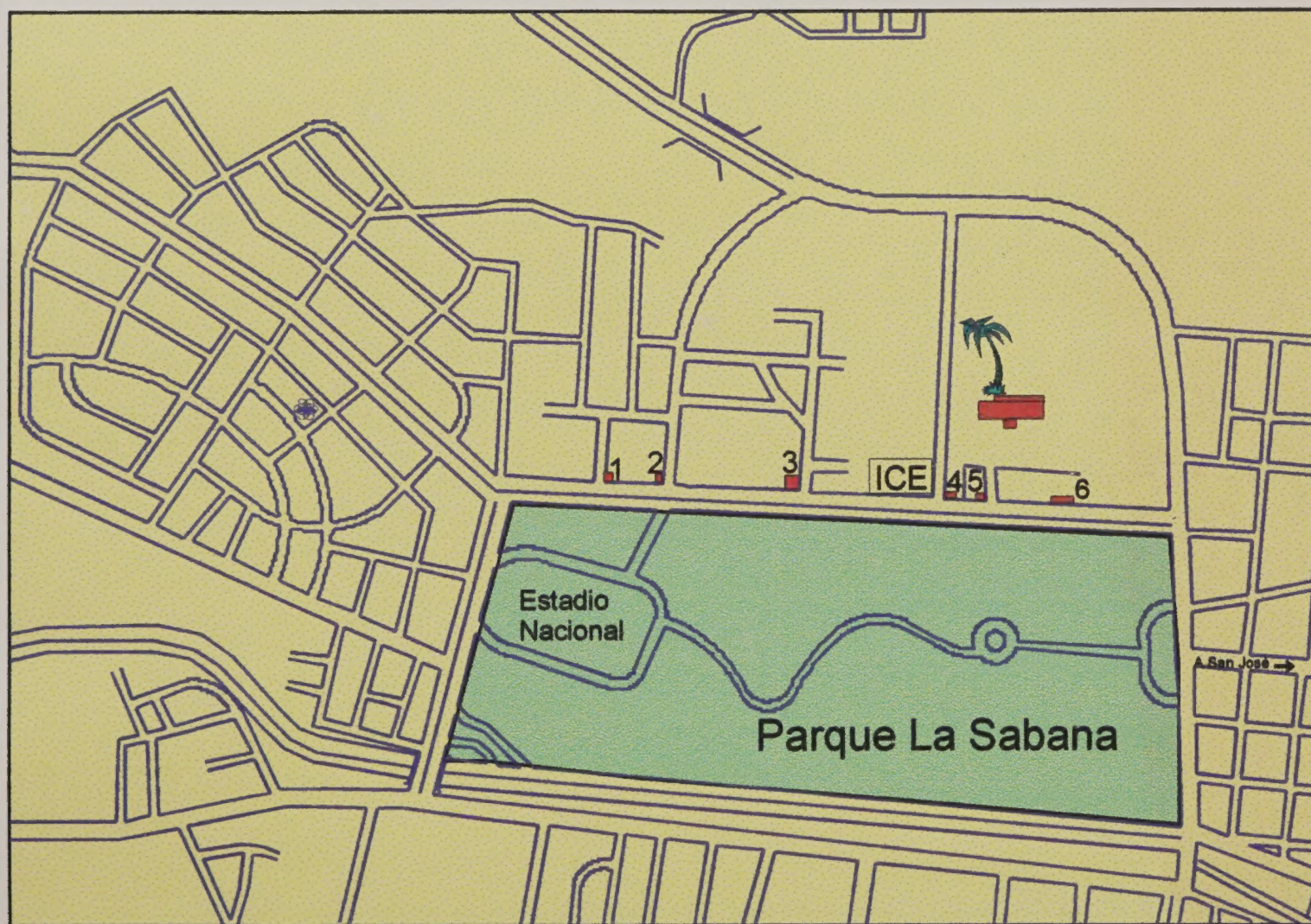
and is obtainable through anonymous ftp from [abraxas.adelphi.edu](ftp://abraxas.adelphi.edu/pub/gis/FAQ) in /pub/gis/FAQ.







# Ubicación de las Oficinas Centrales del PEGB, del Hotel Palma Real y restaurantes aledaños. San José. Costa Rica. 1999.



## SIMBOLOGÍA



Hotel Palma Real  
Centro de conferencia



Oficinas Centrales  
PEGB

## Restaurantes

1. El Chicote (B.B.Q)
2. Las Tunas (Comida Mexicana)
3. El Tizoncito (Comida Mexicana)
4. Subway (Sandwich)
5. Papa John's (Pizza)
6. Burger King

500 0 500 1000 1500 metros









